STATE OF NEW YORK
DEPARTMENT OF CONSERVATION
WATER POWER AND CONTROL
COMMISSION

WITHDRAWAL OF GROUND WATER ON LONG ISLAND, N. Y.

PREPARED BY THE STAFF OF JAMAICA OFFICE OF THE WATER POWER
AND CONTROL COMMISSION UNDER THE DIRECTION OF
ARTHUR H. JOHNSON, ASSOCIATE ENGINEER

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OFFICES

110 STATE STREET, ALBANY 7, NEW YORK

90-79 SUTPHIN BOULEVARD, JAMAICA 2, NEW YORK

FOREWORD

In 1936 the report "Withdrawal of ground water on Long Island, N. Y.", by David G. Thompson and R. M. Leggette was released as Bulletin GW-1. This was the first of a series of ground-water bulletins published by the Water Power and Control Commission of the State of New York, in co-operation with the United States Geological Survey, and with Nassau and Suffolk counties.

Bulletin GW-1 contained and analyzed a chronological review of the withdrawals of water, for public water supply purposes, from 1904 to 1934 inclusive, in Kings, Queens and Nassau counties, according to various source formations. Bulletin GW-28 is essentially a supplement to Bulletin GW-1 bringing the earlier information up to date through 1950. Full recognition and acknowledgement must be given to the earlier work of Mr. Thompson and Mr. Leggette.

WATER POWER AND CONTROL COMMISSION

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WITHDRAWAL OF GROUND WATER ON LONG ISLAND, NEW YORK

BY ARTHUR H. JOHNSON AND W. G. WATERMAN

INTRODUCTION

The first inhabitants of Long Island presumably used the water resources readily available to them in the ponds and springs. With the coming of white settlers and the development of villages and cities the use of water increased, necessitating the construction of supply systems to meet the demand. Data concerning the supply for such systems secured from wells and infiltration galleries have been studied for many years. The large growth in Long Island's population, especially during the past decade, has materially increased the value of its underground water resources.

The drought and unusually hot summer of 1949, which placed New York City's public water supply in jeopardy, focused the attention of many localities on the possible plight of that city. New York City's problem has resulted in a stimulated interest of the general public regarding water supply matters and has made the people aware of the fact that water supplies are not inexhaustible. Therefore, it appears to be an opportune time to issue a new bulletin which will add to the GW-1 material and provide additional factual data from 1904 through 1950.

WATER-BEARING FORMATIONS

In GW-1 the water-bearing beds under Long Island were divided into three major groups based on the geologic age of the formation. Generally these are represented by the shallow, intermediate and deep water-bearing beds. As the further development of wells progresses and additional information becomes available, it appears desirable, starting with 1950, to consider the water-bearing formations as consisting of four major groups, namely: upper Pleistocene (Glacial), Jameco, Magothy (upper Cretaceous) and Lloyd (lower Cretaceous). During previous years the last two formations referred to were considered essentially as one aquifer. Figure 4 indicates the percentage of water which has been pumped for public supply from surface sources and from the different underground aquifers. The division into the four aquifers is shown for 1950 only.

USE OF GROUND WATER

The underground water beds on the island are of primary importance as sources of public water supply and public water supply systems are the largest distributors of that water. In Kings and Queens counties the supply of water for domestic consumption, with the exception of a few small scattered wells, is obtained from public water supply systems. In Nassau county a small proportion of the domestic supply is secured from private individual wells. Because of the more rural nature of Suffolk county, a somewhat greater proportion of the

domestic supply comes from a large number of small private wells. Kings and Queens counties have a large industrial use of water but agricultural use in these counties is negligible. Nassau county has nearly completed its transition from an agricultural to an industrial and residential area. Consequently its agricultural use of water has greatly diminished and the combined domestic and industrial use is increasing. Suffolk county has not yet felt the impact of such a transition but the farm land is now more extensively cultivated. The practice of irrigation by the use of well water has increased in large proportions during the past four years. Estimated public water supply pumpage in Suffolk county during 1950 was 24 million gallons per day, practically all of which was secured from wells put down in the Glacial formation.

Pumpage figures from wells for domestic use in that portion of New York City situated on Long Island do not represent a true picture of the total consumption. About four-fifths of the public water supply used in Kings and Queens counties is secured from the New York City upstate collection system. Based on the 1950 census, the total population of Kings and Queens counties is approximately 4,300,000. The amount of water furnished by water utilities for domestic purposes in these counties during 1950 was at a rate of about 432 million gallons daily, of which about 93 million gallons daily was obtained from wells, infiltration galleries or ponds on Long Island. Thus the equivalent of about 925,000 of this population secures its water from Long Island sources, about half of which are located in Nassau county.

Since the publication of Bulletin GW-1 in 1936 the Flatbush plant of the New York Water Service Corporation, serving a thickly settled area in the center of Kings county, was taken over in 1947 by condemnation by the City of New York. All wells formerly supplying this area were abandoned as sources of a public water supply about June 30, 1947. This corporation, however, continues to operate its Woodhaven plant in the southwestern part of Queens county. The Jamaica Water Supply Company furnishes water to a territory in the south-central portion of Queens county. These two concerns are the only private water supply companies now operating within the boundaries of New York City. Both companies obtain their entire supply from Long Island ground-water sources.

In Nassau county the population has increased from 300,000 in 1930 to 666,000 in 1950. Suffolk county's 1930 population of 160,000 has increased to 272,000 in 1950. The residents of both Nassau and Suffolk counties are entirely dependent on ground-water for their public supply.

The text of Bulletin GW-1 included some estimates on the total withdrawal of ground water from Kings, Queens and Nassau counties, together with statements on the probable period of maximum use. Since GW-1 was published and especially during the past few years, additional data have been collected through surveys, field inspections, pumpage reports, installations of meters, etc. The figures now available embody a considerable volume of additional data so that the included tabulations are probably far more accurate than former estimates. Present data indicate the maximum average daily withdrawal of ground water on Long Island occurred in 1949, when it totalled 271 million gallons. This average daily figure consists of 61 million gallons in industrial pumpage, 190 million gallons in private and public water supply pumpage and 20 million gallons for agricultural purposes.

SCOPE AND ACCURACY OF DATA

The data published in GW-1 covering the period from 1904 to 1934 are reprinted herein and the scope and probable accuracy of those figures are as outlined in that bulletin. Because of the more accurate information recently obtained, it is now believed that some of these former figures probably were too high. There is no proof of this probability and even if revisions were made in accordance with present beliefs, the changes would not materially affect the over-all picture.

The additional data presented in this bulletin have been compiled from reports filed periodically with the Commission by various concerns, from field investigations by the Commission's engineers, officials of the United States Geological Survey and Nassau and Suffolk county authorities or employees, from information furnished by water supply organizations

and other published reports. In a few instances it has been necessary to estimate amounts of pumpage. These estimates are not large enough to influence substantially the accuracy of the final totals, if it later should be shown that the results are incorrect.

CHANGES IN RATE OF WITHDRAWAL SINCE 1904

Table No. 1 shows the average daily withdrawal in Kings, Queens and Nassau counties from 1904 to 1950, inclusive, and Figure 1 shows the same data graphically. The variations in the total withdrawals through 1934 have been commented on in detail in Bulletin GW-1. The variations from 1934 to 1942 appear to be minor and might be classed primarily as seasonal or as a result of fluctuations in industrial activity. In November 1942 the demand for water in the City of New York dropped sufficiently so that the city stopped pumping from its Long Island wells. Except for minor amounts secured in June and July of 1943, the city did not resume general pumping until September of that year. This would account at least in part for the drop shown in 1943. In April 1944, New York City began to take some water from the new Delaware system (Rondout). Variations in the draft by New York City from Long Island from that point through 1950 are caused mainly by precipitation and the operating method followed by the city's water supply authorities. The choice of sources, of course, is influenced by the availability of water in the various reservoirs and the economics of securing the supply from the different portions of the system.

New York City has at times obtained water from Long Island at the rate of 100 million gallons daily. This amount constitutes a substantial proportion of the total Long Island consumption and, therefore, the city's pumpage has a noticeable effect in Table 1.

The graphs accompanying this report do not include industrial pumpage which was estimated at 64.1 million gallons daily during 1950, of which 28.4 million gallons were secured in Kings, 14.5 million gallons in Queens, 8.8 million gallons in Nassau and 12.4 million gallons in Suffolk. This industrial estimate includes institutions whose use in Kings, Queens and Nassau is negligible but amounts to 4.6 million gallons daily in Suffolk. The addition of industrial pumpage would obviously have a considerable effect on the shape or form of this chart.

TABLE NO. I

Summary of average withdrawal of water for public supply in Kings, Queens and Nassau Counties, New York by New York City and other systems, in million gallons daily.

Year	Ground water												Pond Water N.Y.C.	Total
	Kings County			Queens County			.Nassau County			Kings, Queens and Nassau Counties				
	N.Y.City system	Other systems	Total	N.Y.City system	Other systems	Total	N.Y.City system	Other systems	Total	N.Y.City system	Other systems	Total		
1904	8.86	5.90	14.76	15.78	11.16	26.94	5.07	4.00	9.07	29.71	21.06	50.77	83.74	134.51
1905	9.07	6.90	15.97	20.50	11.84	32.34	15.44	4.20	19.64	45.01	22.94	67.95	76.32	144.27
1906	10.00	9.90	19.90	26.71	13.64	40.35	28.42	4.70	33.12	65.13	28.24	93.37	62.61	155.98
1907	11.84	10.80	22.64	37.17	15.04	52.21	28.60	5.10	33.70	77.61	30.94	108.55	57.69	166.24
1908	14.02	13.00	27.02	43.6	15.57	59.17	34.05	5.40	39.45	91.67	33.97	125.64	50.46	176.10
1909	18.47	14.30	32.77	39.20	16.07	55.27	39.50	6.00	45.50	97.17	36.37	133.54	40.23	173.77
1910	17.40	15.10	32.50	45.79	16.69	62.48	44.78	6.20	50.98	107.97	37.99	145.96	34.70	180.66
1911	16.73	14.90	31.63	44.98	20.18	65.16	51.55	6.80	58.35	113.26	41.88	155.14	29.43	184.57
1912	14.56	15.50	30.06	38.27	20.79	59.06	46.20	7.30	53.50	99.03	43.59	142.62	47.63	190.25
1913	12.05	16.00	28.05	32.72	19.36	52.08	49.50	7.60	57.10	94.27	42.96	137.23	38.03	175.26
1914	12.41	15.90	28.31	42.15	15.87	58.02	51.75	8.00	59.75	106.31	39.77	146.08	40.13	186.21
1915	12.29	14.10	26.39	36.73	15.71	52.44	53.43	8.50	61.93	102.45	38.31	140.76	38.92	179.68
1916	14.65	14.60	29.25	38.58	18.61	57.19	54.62	8.70	63.32	107.85	41.91	149.76	37.80	187.56
1917	2.01	14.40	16.41	7.09	19.20	26.29	11.90	9.40	21.30	21.00	43.00	64.00	1.09	65.09
1918	0	13.10	13.10	.05	23.06	23.11	0	9.80	9.80	.05	45.96	46.01	0	46.01
1919	.30	13.00	13.30	.23	22.22	22.45	2.54	10.40	12.94	3.07	45.62	48.69	0	48.69
1920	.37	13.50	13.87	0	24.45	24.45	1.48	10.60	12.08	1.85	48.55	50.40	0	50.40
1921	.83	14.52	15.35	4.35	25.09	29.44	20.27	11.40	31.67	25.45	51.01	76.46	0	76.46
1922	.19	15.49	15.68	7.34	19.39	26.73	25.70	12.20	37.90	33.23	47.08	80.31	3.54	83.85
1923	2.34	16.24	18.58	32.76	17.53	50.29	40.90	13.80	54.70	76.00	47.57	123.57	3.02	126.59
1924	1.23	17.65	18.88	31.07	19.80	50.87	26.20	16.10	42.30	58.50	53.55	112.05	4.35	116.40
1925	0	19.27	19.27	17.56	21.01	38.57	18.76	19.00	37.76	36.32	59.28	95.60	0	95.60
1926	2.87	21.67	24.54	21.49	22.66	44.15	32.94	22.60	55.54	57.30	66.93	124.23	6.96	131.19
1927	0	22.49	22.49	11.74	23.00	34.74	11.30	24.40	35.70	23.04	69.89	92.93	13.90	106.83
1928	0	24.69	24.69	13.44	23.50	36.94	11.75	25.20	36.95	25.19	73.39	19.58	9.12	107.70
1929	0	25.91	25.91	16.51	25.53	42.04	27.40	32.50	59.90	43.91	83.94	127.85	17.12	144.97
1930	.51	26.55	27.06	22.01	28.81	50.82	39.42	34.40	73.82	61.94	89.76	151.70	17.00	168.70
1931	4.80	24.36	29.16	33.92	28.03	61.95	46.91	33.10	80.01	85.63	85.49	171.12	13.40	184.52
1932	.68	25.17	25.85	26.12	30.31	56.43	25.68	31.90	57.58	52.48	87.38	139.86	11.02	150.88
1933	.01	25.21	25.22	13.97	30.91	44.88	15.42	29.70	45.12	29.40	85.82	115.22	12.58	127.80
1934	0	23.75	23.75	16.97	30.81	47.78	24.17	31.70	55.87	41.14	86.26	127.40	16.02	143.42
1935	0	26.18	26.18	20.66	29.33	49.99	25.01	32.97	57.98	45.67	88.48	134.15	15.49	149.64
1936	0	27.43	27.43	22.53	30.30	52.83	26.52	34.70	61.22	49.05	92.43	141.48	20.02	161.50
1937	0	27.95	27.95	14.51	30.13	44.64	19.82	32.78	52.60	34.33	90.86	125.19	21.56	146.75
1938	0	27.68	27.68	7.51	30.85	38.36	17.75	31.94	49.69	25.26	90.47	115.73	24.37	140.10
1939	0	27.08	27.08	10.13	34.24	44.37	26.72	38.36	65.08	36.85	99.68	136.53	26.54	163.07
1940	0	25.28	25.28	8.98	31.86	40.84	26.10	35.67	61.77	35.08	92.81	127.89	27.83	155.72
1941	0.14	25.48	25.62	6.87	34.37	41.24	22.74	38.29	61.03	29.75	98.14	127.89	23.63	151.52
1942	.90	24.60	25.50	13.10	32.50	45.60	31.30	36.70	68.00	45.30	93.80	139.10	28.50	167.60
1943	0	25.10	25.10	1.60	34.90	36.50	3.80	37.80	41.60	5.40	97.80	103.20	13.30	116.50
1944	0	26.88	26.88	4.02	36.58	40.60	21.24	42.93	64.17	25.26	106.39	131.65	16.88	148.53
1945	0	26.64	26.64	2.45	36.64	39.09	7.77	41.29	49.06	10.22	104.57	114.79	4.01	118.80
1946	0	27.74	27.74	.94	38.57	39.51	14.60	45.18	59.78	15.54	111.49	127.03	9.32	136.35
1947	0	13.37	13.37	8.72	39.22	47.94	24.41	48.43	72.84	33.13	101.02	134.15	11.10	145.25
1948	0	0	0	8.39	39.41	47.80	17.46	52.40	69.86	25.85	91.81	117.66	17.87	135.53
1949	0	0	0	10.88	43.69	54.57	28.75	61.11	89.86	39.63	104.80	144.43	14.97	159.40
1950	0	0	0	13.57	37.38	50.95	24.21	58.25	82.46	37.78	95.63	133.41	17.70	151.11

Note: After 1911, all pond water taken from Nassau County, whereas prior to and including this year, pond withdrawals made from Nassau and Queens Counties.
New York Water Service Corp., Flatbush Plant, shutdown June - 1947.

FIGURE - 1

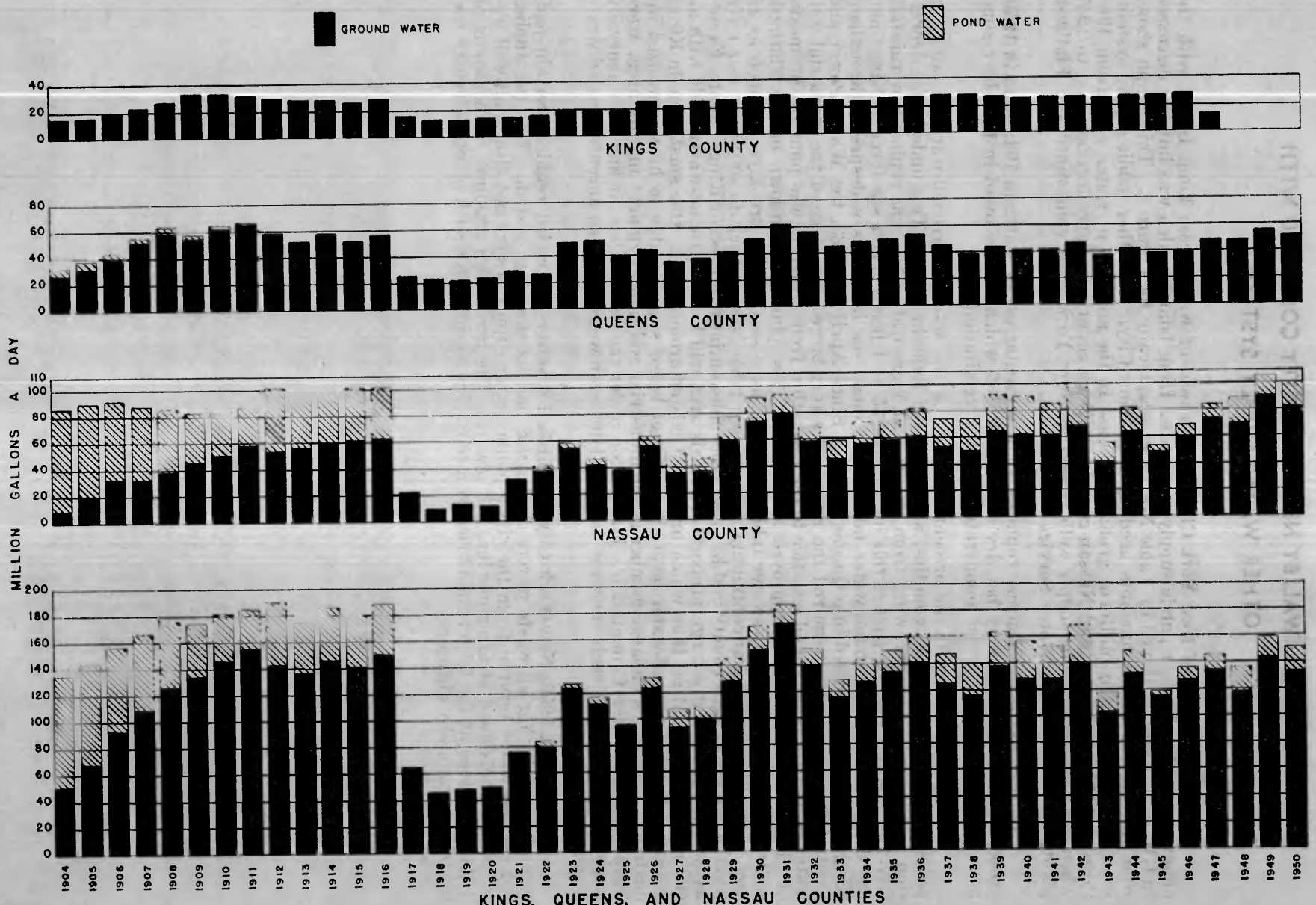

FIGURE 1 - GRAPHS SHOWING AVERAGE DAILY WITHDRAWAL OF WATER FOR PUBLIC SUPPLY IN KINGS, QUEENS, AND NASSAU COUNTIES, NEW YORK.

WITHDRAWAL BY NEW YORK CITY COMPARED WITH OTHER WATER SUPPLY SYSTEMS

The comparison of New York City's withdrawal of water from Long Island with the amounts used by all other public supply systems on Long Island, which was initially discussed in GW-1, has been continued by Table No. 2 and graphically by Figure 2. This graph shows wide fluctuations in the amounts used by New York City. The other public supply systems show an approximately uniform gradual increase in the amounts of water used from 1904 through 1950 for Queens and Nassau counties. Kings county similarly increased up to 1947 when pumpage from public supply wells ceased as New York City condemned the Flatbush plant of the New York Water Service Corporation.

Both Nassau and Queens counties show a greater use of water in 1949 than in 1950, probably because of the very hot dry summer in 1949 which was followed in 1950 by a summer of more nearly normal temperatures and precipitation.

Of special interest in the present situation, is the so-called ground-water "crater" in parts of Kings and Queens counties, as outlined in Bulletin GW-2. This undesirable depression was caused by withdrawing from the ground, more water than was replaced by rainfall. GW-2 showed the deepest part of this hollow was 35 feet below mean sea level in Kings and the depression of the ground-water table below mean sea level was widespread throughout Kings county and extended into Queens county. Since April 28, 1933, the Water Power and Control Commission has required the return of a very large percentage of the industrial well water in all four Long Island counties to the formation from which it was pumped, by means of diffusion wells or other approved structures. This, plus the shutdown of the Flatbush wells, has caused the ground-water table to rise in some sections of Brooklyn as much as 15 feet. The upward trend is continuing. The water table is now back to or above mean sea level in most of Queens county and has also risen substantially in most of Kings county. Eventually it is hoped that a large proportion of this area will have a ground-water table with an elevation approximating that which originally existed around 1903. One small zone in Kings county still has a ground-water level about 30 feet below sea level due to heavy localized industrial pumpage. As a large number of the industrial wells, particularly in this area, were installed prior to the Commission's jurisdiction under the present law, it has been generally impossible to require such concerns to install diffusion wells to return uncontaminated waste water into the ground.

On July 1, 1950, New York City established a sewer tax which requires certain payments to the city for all waste waters discharged into its sewerage system. This tax applies not only to water secured from the city's public water supply system but also to all well water which is disposed of after use into the sewers. The tax, which amounts to thousands of dollars for some of the larger industries, is a powerful incentive for such plants to return water to the ground by diffusers.

TABLE NO. 2

Summary of average daily withdrawal of water for public supply from the different source formations in Kings, Queens, and Nassau Counties, N. Y. in million gallons

	KINGS COUNTY					QUEENS COUNTY						NASSAU COUNTY						KINGS, QUEENS AND NASSAU COUNTIES					
			Cretaceous						Cretaceous						Cretaceous			Pond			Cretaceous		
Year	U. P.	Jameco	Magothy	Lloyd	Total	Ponds	U. P.	Jameco	Magothy	Lloyd	Total	Ponds	U. P.	Jameco	Magothy	Lloyd	Total	Water N.Y.C.	U. P.	Jameco	Magothy	Lloyd	Total
1904	14.15	0.61			0	6.36	23.22	3.72			0	77.38	8.57	0.25			0.25	83.74	45.94	4.58			0.25
1905	15.33	.64			0	5.64	27.83	3.93			.58	70.68	18.12	.25			1.27	76.32	61.28	4.82			1.85
1906	19.13	.77			0	3.61	35.60	3.85			.90	59.00	30.90	.25			1.97	62.61	85.63	4.87			2.87
1907	21.58	1.06			0	3.02	41.76	7.56			2.89	54.67	32.07	.25			1.38	57.69	95.41	8.87			4.27
1908	20.83	6.19			0	3.68	43.62	12.26			3.29	46.78	38.00	.25			1.20	50.46	102.45	18.70			4.49
1909	23.67	8.98			.12	2.53	40.94	10.82			3.51	37.70	43.28	.30			1.92	40.23	107.89	20.10			5.55
1910	24.11	7.94			.45	1.05	45.96	12.47			4.05	33.65	46.42	.30			4.26	34.70	116.49	20.72			8.76
1911	23.63	7.56			.44	.62	44.33	15.07			7.76	28.81	52.90	.30			5.15	29.43	120.86	20.93			13.35
1912	22.94	6.67			.45	0	39.21	10.63			9.22	47.63	48.96	.30			4.24	47.63	111.11	17.60			15.91
1913	22.37	5.32			.36	0	33.37	11.12			7.59	38.03	53.64	.35			3.11	38.03	109.38	16.79			11.06
1914	22.75	5.20			.36	0	37.61	13.27			7.14	40.13	55.07	.35			4.33	40.13	115.43	18.82			11.83
1915	20.06	5.96			.37	0	32.56	13.21			6.67	38.92	57.37	.37			4.19	38.92	109.99	19.54			11.23
1916	22.05	6.78			.42	0	36.94	13.33			6.92	37.80	58.06	.37			4.89	37.80	117.05	20.48			12.23
1917	15.87	.48			.06	0	17.34	3.58			5.37	1.09	19.40	.40			1.50	1.09	52.61	4.46			6.93
1918	13.10	0			0	0	16.14	1.73			5.24	0	8.40	.40			1.00	0	37.64	2.13			6.24
1919	13.26	.04			0	0	15.37	1.83			5.25	0	11.44	.40			1.10	0	40.07	2.27			6.35
1920	13.87	0			0	0	16.23	2.03			6.19	0	10.58	.40			1.10	0	40.68	2.43			7.29
1921	15.35	0			0	0	17.90	4.71			6.83	0	29.87	.50			1.30	0	63.12	5.21			8.13
1922	15.68	0			0	0	19.54	1.56			5.63	3.54	35.95	.60			1.35	3.54	71.17	2.16			6.98
1923	17.22	1.36			0	0	36.11	11.82			2.36	3.02	51.09	.70			2.91	3.02	104.42	13.88			5.27
1924	17.77	1.11			0	0	33.10	8.85			8.92	4.35	37.70	.80			3.80	4.35	88.57	10.76			12.67
1925	19.27	0			0	0	26.51	3.41			9.07	0	33.47	.80			3.49	0	79.25	4.21			12.14
1926	23.94	.35			.25	0	30.97	6.17			7.01	6.96	48.98	.90			5.66	6.96	103.89	7.42			12.92
1927	21.31	.74			.44	0	26.53	3.08			5.13	13.90	26.40	1.10			8.20	13.90	74.24	4.92			13.77
1928	23.44	.83			.42	0	26.63	3.76			6.55	9.12	25.42	1.20			10.33	9.12	75.49	5.79			17.30
1929	22.68	2.71			.52	0	29.32	3.95			8.77	17.12	42.11	1.70			16.09	17.12	94.11	8.36			25.36
1930	17.51	6.99			2.56	0	34.59	6.71			9.52	17.00	54.10	1.70			18.02	17.00	106.20	15.40			30.10
1931	13.21	12.92			3.03	0	33.13	12.29			16.53	13.40	60.02	1.60			18.39	13.40	106.36	26.81			37.95
1932	9.48	14.82			1.55	0	33.84	9.83			13.76	11.02	37.50	1.70			18.38	11.02	79.82	26.35			33.69
1933	9.45	14.94			.83	0	26.45	5.71			12.72	12.58	26.78	1.40			16.94	12.58	62.68	22.05			30.49
1934	10.68	12.48			.59	0	27.19	6.74			13.85	16.02	36.78	1.54			17.55	16.02	74.65	20.76			31.99
1935	13.46	12.40			.32	0	27.66	7.28	10.97	4.08	15.05	15.49	36.53	1.63			19.82	15.49	77.65	21.31			35.19
1936	14.14	12.97			.32	0	29.72	7.76	10.19	5.16	15.35	20.02	33.19	7.25			20.78	20.02	77.05	27.98			36.45
1937	14.16	13.41			.38	0	24.80	5.50	8.89	5.45	14.34	21.56	24.66	6.48			21.46	21.56	63.62	25.39			36.18
1938	13.83	13.36			.49	0	21.29	2.09	8.40	6.58	14.98	24.37	22.27	6.54			20.88	24.37	57.39	21.99			36.35
1939	14.04	12.28			.76	0	27.93	2.60	9.50	4.34	13.84	26.54	31.87	7.22			25.99	26.54	73.84	22.10			40.59
1940	12.74	12.00			.54	0	25.88	2.00	6.72	6.24	12.96	27.83	30.06	6.63			25.08	27.83	68.68	20.63			38.58
1941	13.15	11.91			.56	0	25.23	3.38	6.51	6.12	12.63	23.63	28.33	7.14			25.56	23.63	66.71	22.43			38.75
1942	12.72	12.64			.14	0	25.73	5.24	8.05	6.58	14.63	28.50	34.72	6.72			26.56	28.50	73.17	24.60			41.33
1943	14.73	10.09			.28	0	23.49	3.55	3.41	6.05	9.46	13.30	9.90	6.90			24.80	13.30	48.12	20.54			34.54
1944	18.14	8.50			.24	0	24.89	3.62	6.22	5.87	12.09	16.88	27.82	6.81	22.30	7.24	29.54	16.88	70.85	18.93			41.87
1945	18.85	7.56			.23	0	25.17	3.76	4.38	5.78	10.16	4.01	14.04	7.19	20.13	7.70	27.83	4.01	58.06	18.51			38.22
1946	18.96	8.66			.12	0	26.33	3.58	3.96	5.64	9.60	9.32	21.14	7.88	22.06	8.70	30.76	9.32	66.43	20.12			40.48
1947	10.46	2.91			0	0	30.09	4.77	7.18	5.90	13.08	11.10	30.56	8.14	25.36	8.78	34.14	11.10	71.11	15.82	32.54	14.68	47.22
1948	0	0			0	0	29.96	5.36	7.23	5.25	12.48	17.87	22.81	8.56	29.09	9.40	38.49	17.87	52.77	13.92	36.32	14.65	50.97
1949	0	0			0	0	32.46	7.81	8.28	6.02	14.30	14.97	34.89	7.84	36.93	10.20	47.13	14.97	67.35	15.65	45.21	16.22	61.43
1950	0	0			0	0	29.94	5.49	8.78	6.74	15.52	17.70	30.29	6.33	35.92	9.92	45.84	17.70	60.23	11.82	45.94	15.42	61.36

FIGURE-2

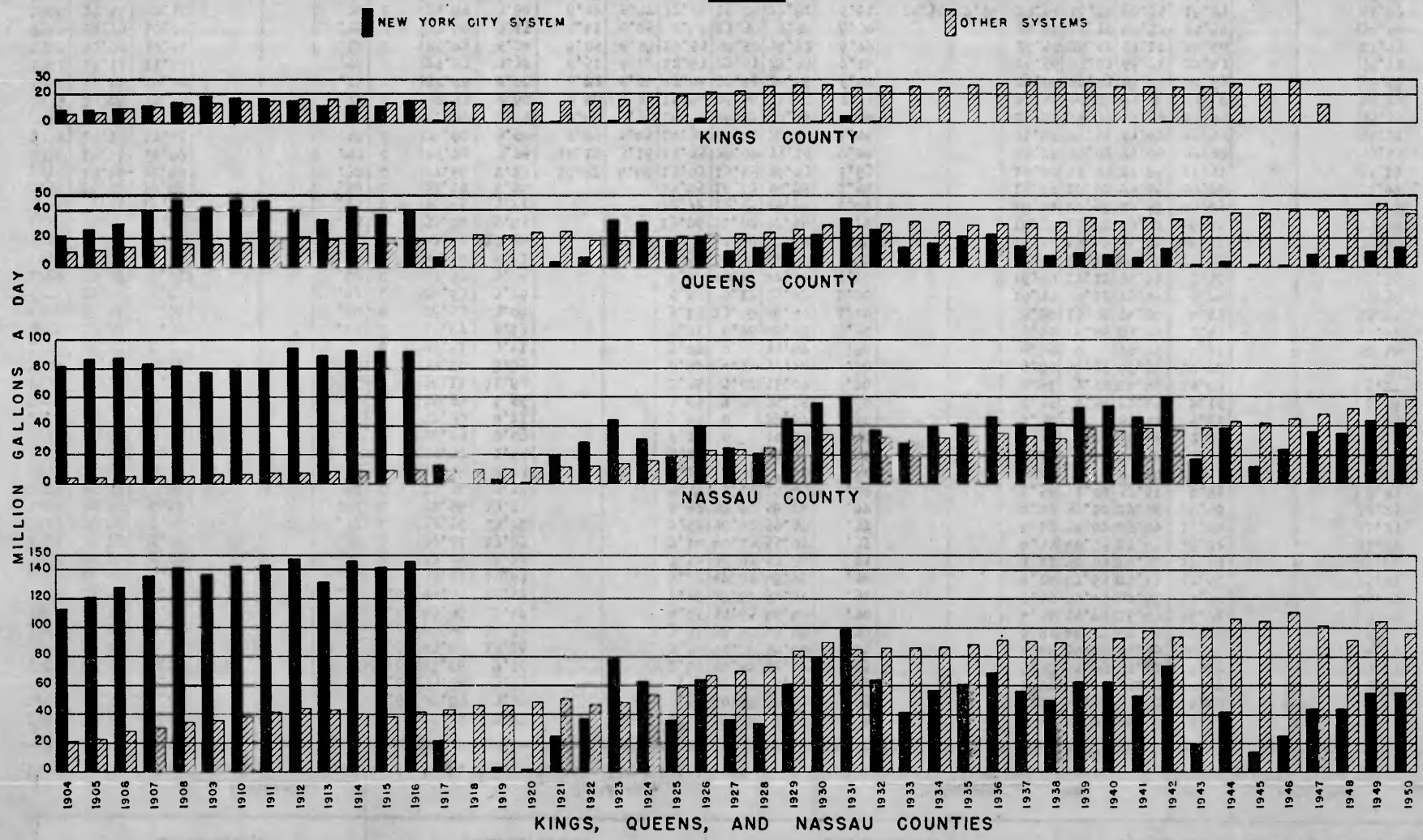

FIGURE 2 - GRAPHS SHOWING AVERAGE DAILY WITHDRAWAL OF WATER FOR PUBLIC SUPPLY IN KINGS, QUEENS, AND NASSAU COUNTIES, N.Y. BY NEW YORK CITY AND OTHER SYSTEMS.

WITHDRAWALS FROM THE DIFFERENT SOURCE FORMATIONS

Withdrawal from the different source formations is shown numerically on the tabulations, graphically on Figures 3 and 3A, and by percentages on Figure 4. The reasons enumerated in GW-1 which explain why such a subdivision into the different source formations was only approximate in the earlier years also apply to the additional data now being presented in this report. Also as stated in GW-1 it is probable that the so-called pond water occurring on the island is really from the upper Pleistocene aquifer. Therefore, it might be correct to combine the upper Pleistocene and pond water figures on the tabulations and graphs.

Figure 3 shows that the largest quantity of water drawn for public supply in each of the three western counties has come from the upper Pleistocene formation. There has been no draft from this aquifer since 1947 in Kings county due to cessation of pumpage at the Flatbush plant of the New York Water Service Corporation. In Queens county the withdrawal has been fairly uniform since 1934, with the upper Pleistocene averaging about 25 million, the Jameco 5 million, and the Cretaceous 12 million gallons daily. Nassau county shows more marked changes due principally to the variation in the amount of New York City's pumpage, the doubling of Nassau county's population and an influx of industry. The total of water in that county from the Jameco formation has remained practically uniform for the 1936-51 period. The quantity of water secured from the Nassau county Cretaceous formation has shown a steady increase for the 1933-50 period. In 1930 approximately 18 million gallons were being used daily from this formation and in 1950 about 45 million gallons were pumped daily. This increase ties in directly with the population of Nassau county. In the future it is not improbable that these deeper formations will be the principal sources of supply. The shallow aquifers may not be able to meet the increased demands of this rapidly developing territory and may become contaminated by the disposal of sewage into cesspools or by salt water intrusion.

FIGURE - 3

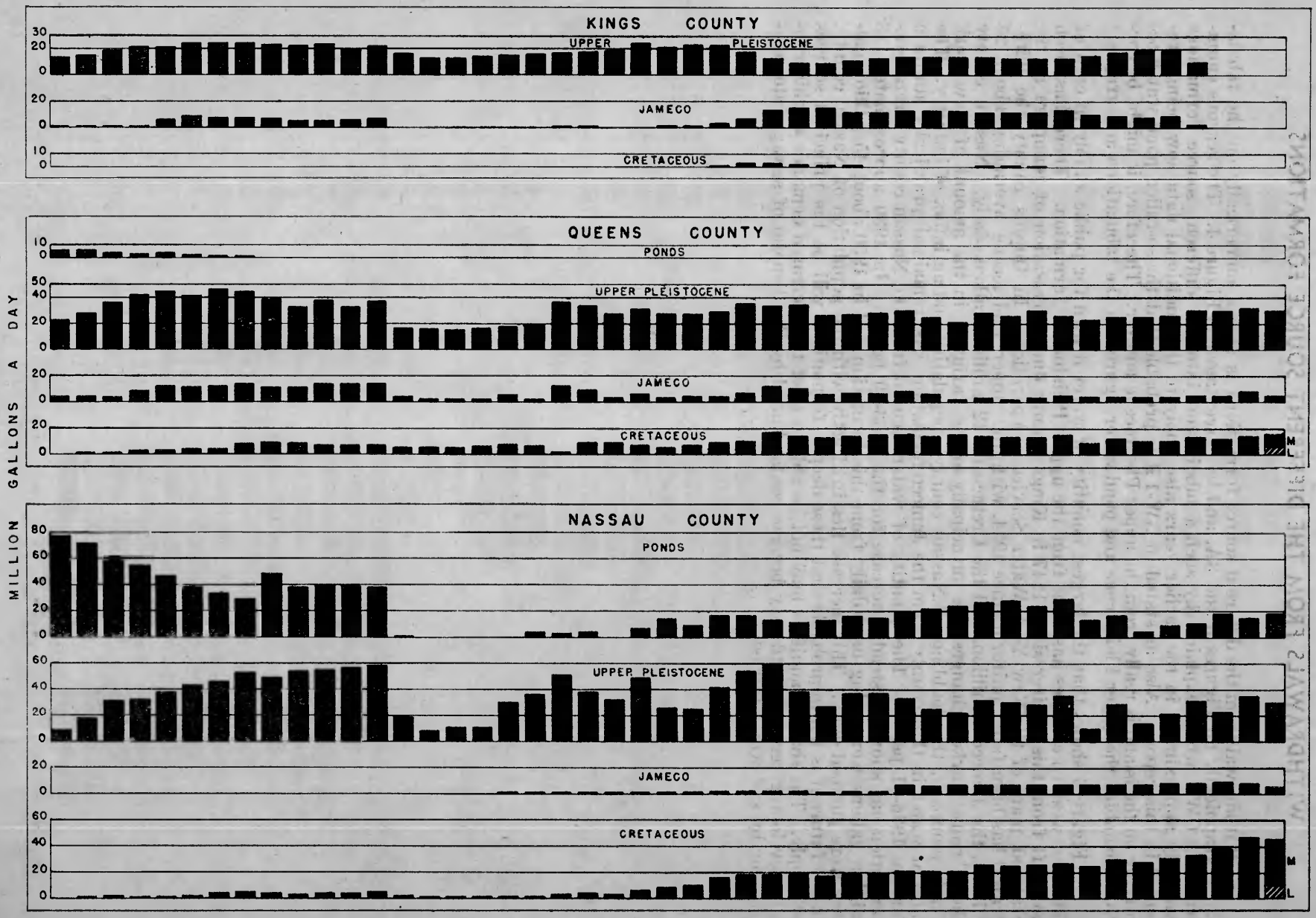

FIGURE 3 — GRAPHS SHOWING AVERAGE DAILY WITHDRAWAL OF WATER FOR PUBLIC SUPPLY FROM THE DIFFERENT SOURCE FORMATIONS IN KINGS, QUEENS, AND NASSAU COUNTIES, N.Y.
NOTE: AS OF 1950 CRETACEOUS IS DIVIDED INTO MAGOTHY AND LLOYD COMPONENTS.

FIGURE - 3A

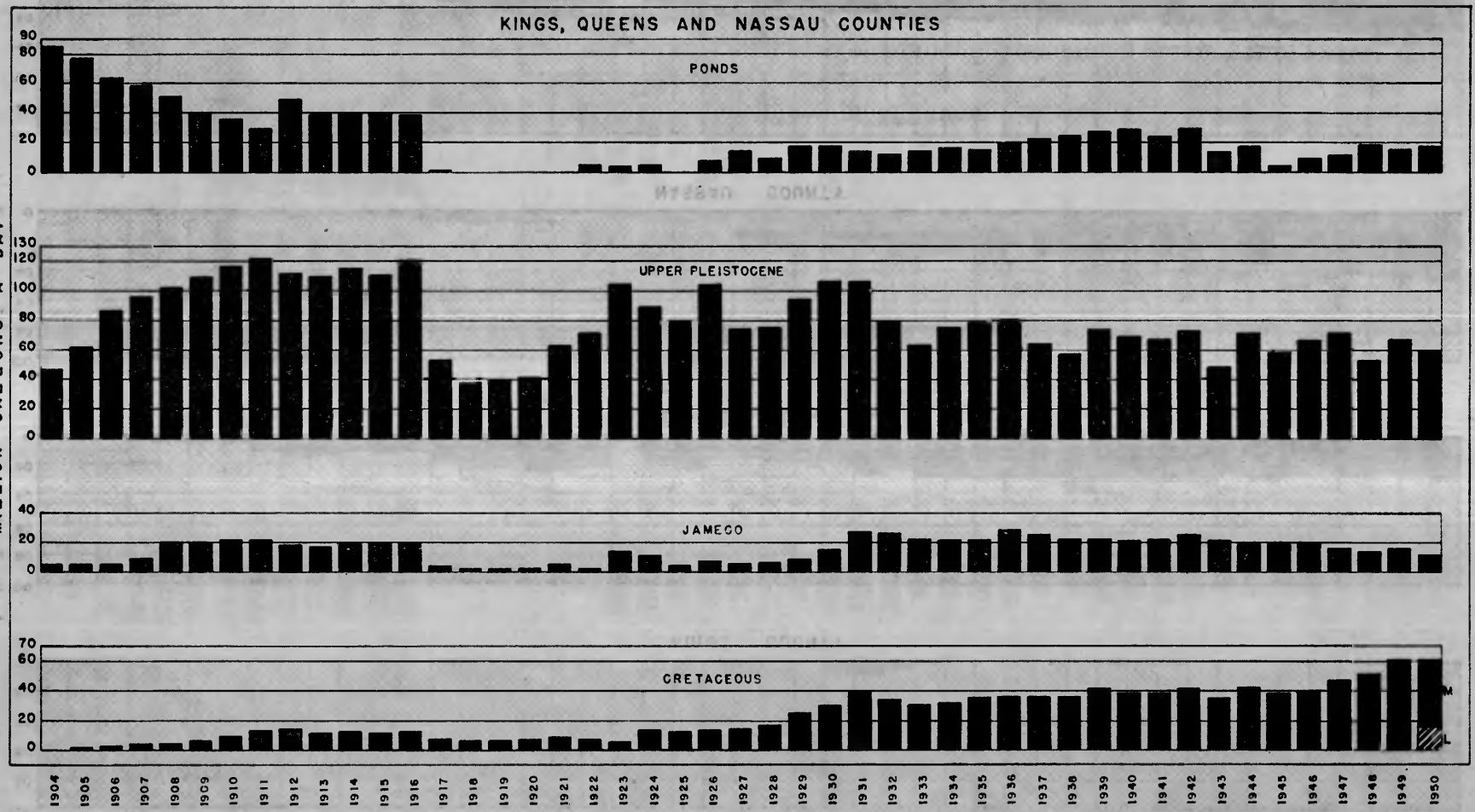

FIGURE 3A-GRAPHS SHOWING AVERAGE DAILY WITHDRAWAL OF WATER FOR PUBLIC SUPPLY FROM THE DIFFERENT SOURCE FORMATIONS IN KINGS, QUEENS, AND NASSAU COUNTIES, N. Y. - CONTINUED

NOTE: AS OF 1950 CRETACEOUS IS DIVIDED INTO MAGOTHY AND LLOYD COMPONENTS.

FIGURE-4

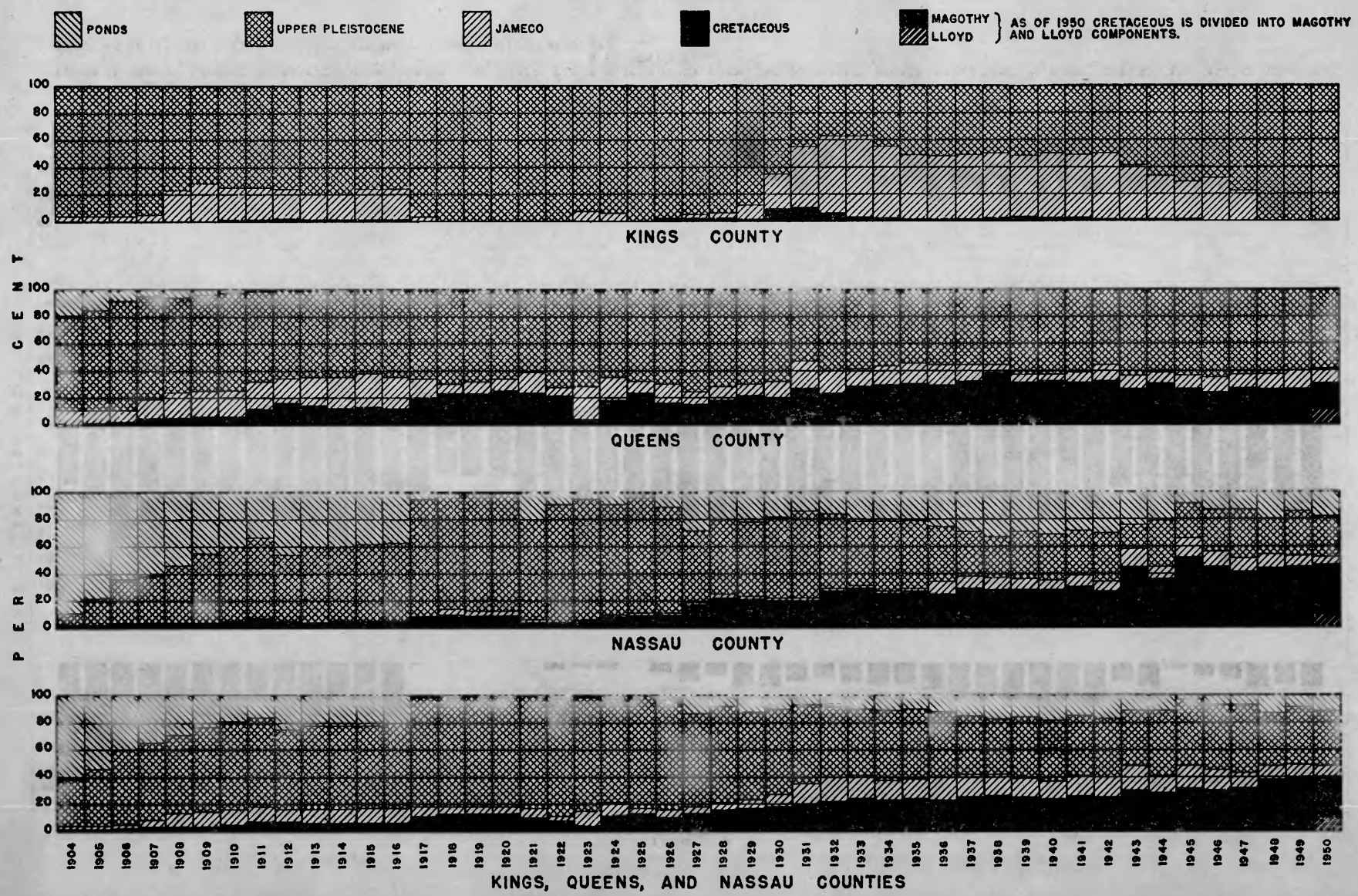

FIGURE 4 - GRAPHS SHOWING PERCENTAGE OF WATER FOR PUBLIC SUPPLY DERIVED FROM THE DIFFERENT SOURCE FORMATIONS IN KINGS, QUEENS, AND NASSAU COUNTIES, N. Y.

Table 5 shows approximately the average daily withdrawal and the location of well fields, at each of the public water supply pumping stations in the three western counties in 1950. A similar map appears in GW-1 for the year 1930. The most striking difference between the two maps is the cessation of practically all pumping for public water supply purposes in Kings county. Another striking difference is the marked increase as shown on the 1950 map in the amount of public water supply for practically each of the Nassau county villages. This increase, of course, has been caused primarily by the doubling of the county's population between 1930 and 1950. A further difference which can be deduced from comparison of the 1930 and 1950 maps, is the conversion of former farm land into the residential area which has been developed into the Levittown Water District.